CHAPTER 14
SPECIAL CONSIDERATIONS

This chapter discusses the special procedures applied to some missions to effectively engage targets.

14-1. REGISTRATION AND SHEAF ADJUSTMENT

Firing the registration is the first mission that will be completed if time and the tactical situation permit.

a. **Firing Coordinated and Noncoordinated Missions**. Two types of registration missions are fired on the surveyed chart: coordinated and noncoordinated.

(1) *Firing coordinated missions*. The FDC and FO coordinate the location of the RP before the FO joins the unit to support it. Once the FO is in position, the FDC sends a message telling the FO to prepare to register RP 1. The FO sends the OT direction to the RP.

(2) *Firing noncoordinated missions*. The FO, upon joining the unit to support it, checks the area of responsibility and selects a point to be used as the RP. This point must be identifiable both on the ground and on the map to allow a valid eight-digit grid to be determined. The FO then sends the call for fire to register the RP.

b. **Constructing Surveyed Firing Chart**. The surveyed firing chart is the most accurate chart that can be constructed. It can be used to determine all the correcting factors that are needed to fire more first-round FFE missions than the other firing charts. Three items must be known to construct the surveyed chart: a grid intersection to represent the pivot point, a surveyed mortar position, and a surveyed registration point. (The construction of the surveyed chart is similar to the modified-observed chart.)

(1) To obtain the DOF after constructing the chart, align the mortar position with the RP. Determine the DOF to the nearest mil.

(2) To determine the mounting azimuth, round off the DOF to the nearest 50 mils.

(3) To superimpose the deflection scale, the referred deflection is received from the section sergeant. Then, construct the deflection scale in the same manner as for the modified-observed chart.

NOTE: The procedure to obtain the firing data is the same as with all firing charts.

(4) Determine correction factors after the registration has been completed. Apply these factors to all other targets within the transfer limits of the RP.

c. **Obtaining Firing Data**. Obtaining the firing data is the same as with any mission, except that the FO continues to adjust until a 50-meter bracket is split and the last fired round is within 25 meters of the target (Figure 14-1). Refinement corrections are sent to the FDC and the mission is ended. Table 14-1 provides information to be used in setting up the plotting boards to fire a surveyed registration. (See FM 6-30.)

OBSERVER CORRECTION			CHART DATA		SUBSEQUENT COMMANDS						
DEV	RANGE	TIME (HEIGHT)	DEFL	CHARGE (RANGE)	MORTAR FIRE	METHOD FIRE	DEFL	RANGE / CHARGE	TIME (SETTING)	ELEV	
	-100		2791	18 7/8			2833	19 1/8		0900	2
R50	+50		2781	19 7/8			2823	19 4/8		0900	3
	-25	EOM R/E	2779	19 1/8	MTO: PREPARE TO ADJ THE SHEAF						

Figure 14-1. Splitting of a 50-meter bracket.

MORTAR GRID:	0086 6158	ALT: 0520
RP 1 GRID:	9953 5884	ALT: 0470
GRID INTERSECTION:		01/59
DOF:		3660 MILS
MAZ:		3650 MILS
REF DEF:		2800 MILS
INIT DEF (1ST RD):		2790 MILS

Table 14-1. Plotting of a surveyed registration.

d. **Adjusting the Sheaf**. The purpose of adjusting the sheaf is to get all mortars firing parallel. Mortars are positioned with gun No. 1 through 4 for the 81-mm mortars, No. 1 through 6 for the 4.2-inch and 120-mm mortar (when employed as a platoon), or No. 1 through 3 for the 4.2-inch and 120-mm mortar (when employed as a section) from right to left as seen from behind the guns. There is normally a 10-second interval between rounds. The FO needs that time to observe the impact of the rounds and to determine corrections. If the corrections are 50 meters or more (deviation left/right only), the mortar must be refired. The corrections can be plotted on the board, or the DCT (Figure 14-2) can be used to determine the number of mils to add or subtract from the base mortar deflection.

RANGE IN METERS	DEFLECTION IN METERS														
	1	10	20	30	40	50	75	100	125	150	175	200	300	400	500
500	3.0	20	41	61	81	102	152	201	250	297	34	388	550	687	800
600	1.7	17	34	51	68	85	127	168	209	250	289	328	472	599	708
700	1.5	15	29	44	58	73	109	145	180	215	250	284	412	529	632
800	1.3	13	25	33	51	64	95	127	158	189	219	250	365	472	569
900	1.1	11	22	34	45	57	85	113	141	168	195	223	328	426	517
1000	1.0	10	20	31	41	51	76	102	127	152	176	201	297	388	473
1100	.93	9	18	28	37	46	69	92	115	138	161	183	271	355	435
1200	.85	8	17	25	34	42	64	85	106	127	148	168	249	328	402
1300	.79	8	16	23	31	39	59	78	98	117	136	155	231	304	374
1400	.73	7	15	22	29	36	55	73	91	109	127	145	215	283	349
1500	.68	7	14	20	27	34	51	68	85	102	118	135	201	265	328
1600	.63	6	13	19	25	32	48	64	80	95	111	127	189	250	309
1700	.60	6	12	18	24	30	45	60	75	90	104	119	178	235	291
1800	.57	6	11	17	23	28	42	57	71	85	99	113	168	223	276
1900	.54	5	11	16	21	27	40	54	67	80	94	107	160	211	262
2000	.51	5	10	15	20	25	38	51	64	76	89	102	152	201	250
2100	.49	5	10	15	19	24	36	48	61	73	85	97	145	192	238
2200	.46	5	9	14	19	23	35	46	58	69	81	92	138	183	228
2300	.44	4	9	13	18	22	33	44	55	66	77	88	132	175	218
2400	.43	4	8	13	17	21	32	42	53	63	74	85	127	168	209
2500	.41	4	8	12	16	20	31	41	51	61	71	81	122	162	201
2600	.39	4	8	12	16	20	29	39	49	59	68	78	117	155	194
2700	.38	4	8	11	15	19	28	38	47	57	66	75	113	150	187
2800	.37	4	7	11	15	18	27	36	45	55	64	73	109	145	180
2900	.35	4	7	11	14	18	26	35	44	53	61	70	105	140	174
3000	.34	3	7	10	14	17	25	34	42	51	59	68	102	135	168
3100	.33	3	7	10	13	16	25	33	41	49	57	66	98	131	163
3200	.32	3	6	10	13	16	24	32	40	48	56	64	95	127	158
3300	.31	3	6	9	12	15	23	31	39	46	54	62	92	123	153
3400	.30	3	6	9	12	15	22	30	37	45	52	60	90	119	149
3500	.30	3	6	9	12	15	22	29	36	44	51	58	87	116	145
3600	.29	3	6	8	11	14	21	28	35	42	49	57	85	113	141
3700	.28	3	6	8	11	14	21	28	34	41	48	55	82	110	137
3800	.27	3	5	8	11	13	20	27	33	40	47	54	80	107	133
3900	.27	3	5	8	10	13	20	26	33	39	46	52	78	104	130
4000	.26	3	5	8	10	13	19	26	32	38	45	51	76	102	127

Figure 14-2. Deflection conversion table.

NOTE: If the target has been mechanically surveyed, enter the DCT at the initial range plot. If the target is a nonsurveyed target (even if it is an eight-digit grid), enter the DCT at the final range plot.

EXAMPLE

The sheaf of a 81-mm platoon is being adjusted. No. 2 mortar conducted the registration. The FDC has requested to prepare to adjust the sheaf. The FO requests section right. The entire platoon then fires, in order, starting at the right (No. 1, 3, 4) with 10-second intervals between rounds. The mortar that was used to register (No. 2) will not fire. The sheaf is adjusted perpendicular to the gun-target line. The observer notes where each round lands and sends back deviation corrections in meters; range corrections are ignored if less than 50 meters. If a deviation correction is 50 meters or more, it must be refired. Corrections to be refired should always be transmitted first by the FO.

If angle T is greater than 499 mils, each piece is adjusted onto the registration point, and the FDC computes the data for the sheaf. In adjusting the sheaf, all rounds must be adjusted on line at about the same range (within 50 meters) and with the lateral spread between rounds equal to the bursting diameter of the ammunition used.

The spottings from the FO are No. 4, right 20, No. 3, left 60, and No. 1, left 30 (Figure 14-3). The FO then sends these corrections to the FDC; No. 3, right 60 (because it needs to be refired), No. 4, left 20 No. 4 is adjusted, and finally No. 1, right 30 No. 1 is adjusted. The No. 3 mortar is now fired, and the round impacts 10 meters right of the desired burst point. The FO would then send: No. 3, left 10, No. 3 is adjusted, sheaf is adjusted, end of mission.

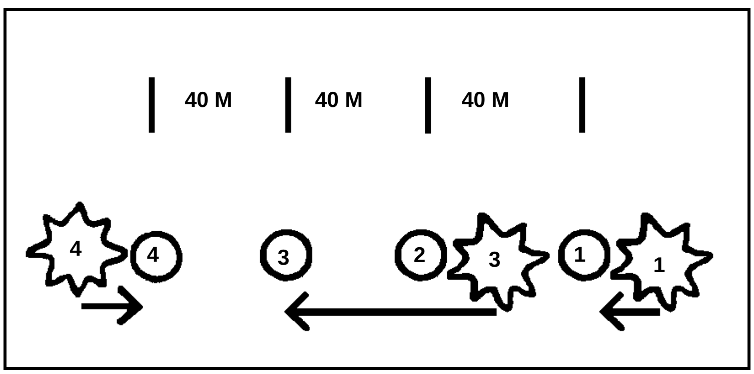

Figure 14-3. No. 1, No. 3, and No. 4 mortars out of sheaf.

e. **Obtaining Corrections Using the Deflection Conversion Table**. The computer enters the DCT at the initial chart range rounded to the nearest 100 meters: 3050 = 3100. (Remember, the RP is at a surveyed grid, and it has not moved.) Using the deflection in meters line at the top of the table, the computer finds the meters needed to correct the sheaf. Where the range line and the correction line meet is the number of mils needed to apply. He applies the mils to the base deflection. (When working with deflections, use the LARS rule.) Once the FO has given EOM, "Sheaf adjusted," the section is given, "Section, refer deflection two eight zero one (2801), realign aiming posts," (2801 was the base mortar's hit deflection). This procedure allows all mortars to be fired with the same data, and the resulting sheaf will be parallel.

f. **Determining Firing Corrections**. Once registration is completed, the firing corrections (range correction factor and deflection correction) are determined for use within the transfer limits of the RP (Figure 14-4). The computer applies correction factors to correct for nonstandard conditions (weather and equipment wear) affecting the round.

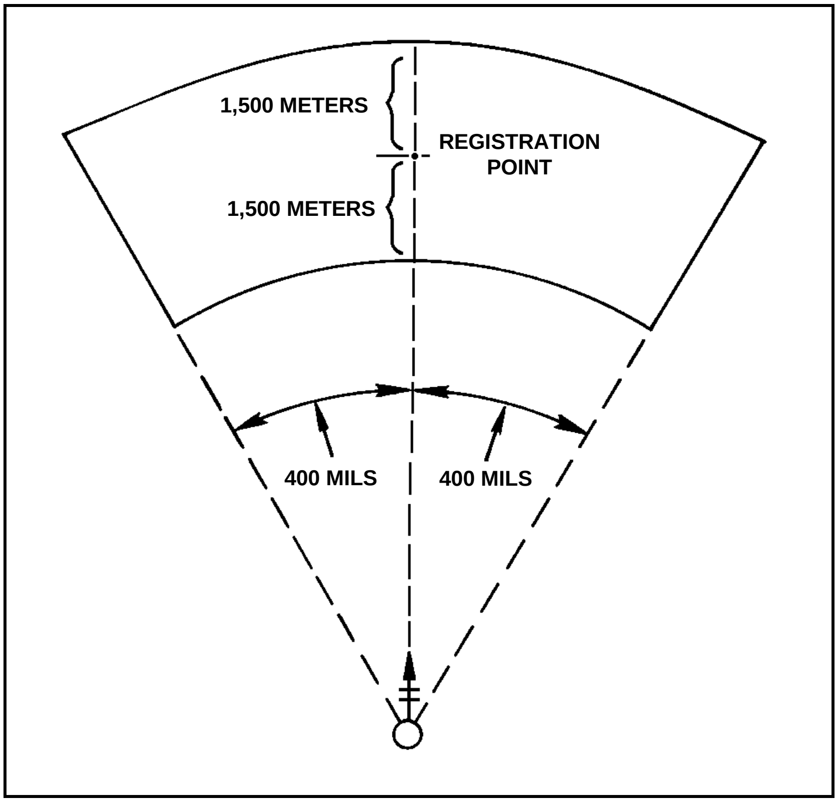

Figure 14-4. Transfer limits for one registration point.

Range correction is the difference in meters between the initial chart range and the final chart range for the RP. As the registration mission is fired and completed, the rounds on the plotting board may not be plotted at the point where the RP was plotted. Because of wind and weather, the rounds may have to be fired at a greater or lesser range and to the right or left of the target to hit it. As shown in Figure 14-5, the initial chart range to the RP was 3,050 meters; the final adjusted chart range (range used to hit the RP) was 3,200.

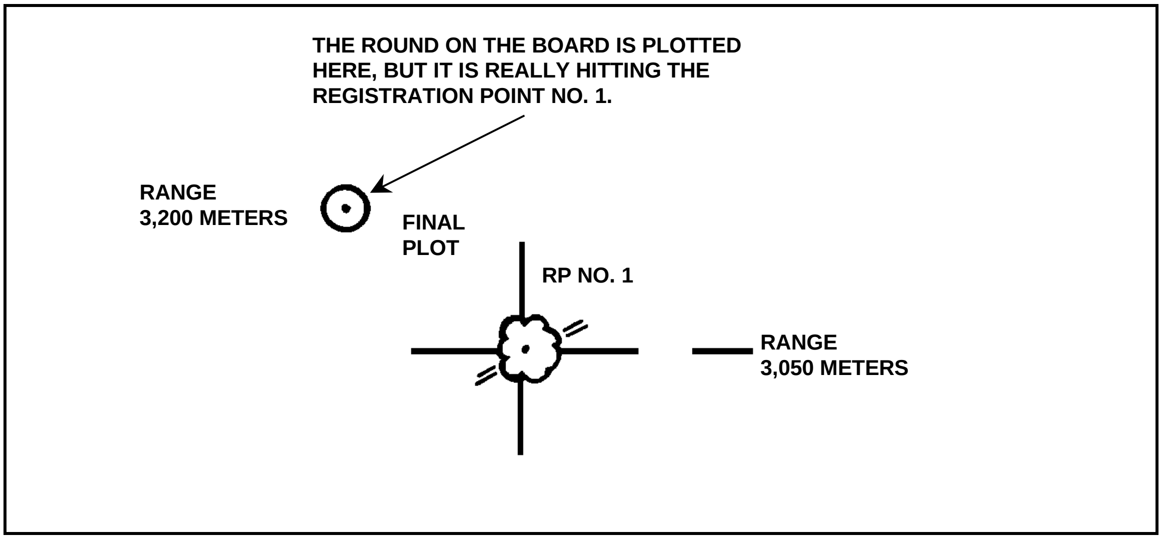

Figure 14-5. Plotting of rounds.

g. **Determining Range Difference**. The computer compares the initial chart range and the final adjusted chart range and subtracts the smaller from the larger. This gives the range difference. If the initial chart range is larger than the final adjusted chart range, then the range correction is a minus (-). If it is smaller, then the range correction is a plus (+).

EXAMPLE

Initial chart range smaller: 3,050; final adjusted chart range: 3,200
Then, 3,200 - 3,050 = +150 meters.

Initial chart range larger: 3,200; final adjusted chart range: 3,050
Then 3,200 - 3,050 = -150 meters.

(1) *Range correction factor*. The RCF is the number of meters per thousand to be applied to the initial chart range of a target within the transfer limits resulting in a range correction for that mission. Continuing the preceding example, since the ranges to other targets will not be 3,050 (range to RP), the RCF (+150) will not be correct. Therefore, other range corrections must be determined and used for other targets. Once the range difference has been determined, round the initial chart range to the nearest 100 and then express that in thousandths.

EXAMPLE

Initial chart range: 3,050.
Round to nearest 100 = 3,100
expressed in thousandths = 3.1.
Divide the range in thousandths into the range difference: +150.

```
     48.3  = +48 RCF
3.1/+150.00
    124
     260
    248
    120
     93
     27
```

Determine to the nearest whole meter and use the sign of the range correction.

(2) *Deflection correction*. The deflection correction is the number of mils needed to correct the deflection to hit the target since nonstandard conditions again caused the plots on the board to be either left or right of the initial chart deflection (Figure 14-6). Compare the initial chart deflection and the final chart deflection and subtract the smaller from the larger.

RULE: Final chart deflection (hit) larger = LEFT deflection correction; final chart deflection (hit) smaller = RIGHT deflection correction.

EXAMPLE

Hit Larger

Hit deflection: 2801
Initial chart deflection: 2790
(2801 - 2790 = L11)

EXAMPLE

Hit Smaller

Hit deflection: 2790
Initial chart deflection: 2801
(2790 - 2801 = R11)

Range and deflection corrections are applied to all other targets within the transfer limits of the RP.

h. **Firing of a Total Range Correction Mission**. The procedure for a mission on the surveyed chart is the same as with the modified-observed chart. However, now the firing corrections are applied to chart data to obtain command data (firing data sent to the mortars). For example, the computer assumes that the board is still set up on the information for the registration mission, and the mission in Figure 14-6 has been received. It is within the transfer limits.

COMPUTER'S RECORD

For use of this form, see FM 23-91. The proponent agency is TRADOC.

ORGANIZATION	DATE	TIME	OBSERVER ID	TARGET NUMBER
B Co 1/29 IN			P88	AB0101

☑ ADJUST FIRE ☐ FIRE FOR EFFECT
☐ IMMEDIATE SUPPRESSION

GRID: ____
OT DIRECTION: ____
ALTITUDE: ____

SHIFT FROM: RP # 1
OT DIRECTION: 3550 ALTITUDE: ____
☐ LEFT / ☑ RIGHT 200
☐ ADD / ☑ DROP 100
☐ UP / ☐ DOWN ____

POLAR:
OT DIRECTION: ____ ALTITUDE: ____
DISTANCE: ____
☐ UP / ☐ DOWN ____
VERTICAL ANGLE ☐ + / ☐ – ____

TARGET DESCRIPTION: PIO
METHOD OF CONTROL:
METHOD OF ENGAGEMENT: PROX in FFE
MESSAGE TO OBSERVER:

FDC ORDER

- MORTAR TO FFE: Sec
- MORTAR TO ADJ: #2
- METHOD OF ADJ: 1 Rd
- BASIS FOR CORRECTION: RP1
- SHEAF CORRECTION:
- SHELL AND FUZE: HEQ in ADJ PROX in FFE
- METHOD OF FFE: 3 Rds
- RANGE LATERAL SPREAD:
- ZONE:
- TIME OF OPENING FIRE: W/R

INITIAL CHART DATA

- DEFLECTION: 2715
- DEFLECTION CORRECTION: ☑ L ☐ R
- RANGE: 2975
- VI/ALT CORRECTION: 50 ☐ + ☑ – 25
- RANGE CORRECTION: +144
- TRC ☑ + ☐ – 119
- CHARGE/RANGE: 6/3100
- AZIMUTH: 3360
- ANGLE T: 190

INITIAL FIRE COMMAND

- MORTAR TO FOLLOW: Sec
- SHELL AND FUZE: HEQ
- MORTAR TO FIRE: #2
- METHOD OF FIRE: 1 Rd
- 3 Rds PROX in FFE
- DEFLECTION: 2726
- CHARGE: 6
- TIME SETTING:
- ELEVATION: 0991

ROUNDS EXPENDED: 1 HE

OBSERVER CORRECTION: DEV	RANGE	TIME (HEIGHT)	CHART DATA: DEFL	CHARGE (RANGE)	SUBSEQUENT COMMANDS: MORTAR FIRE	METHOD FIRE	DEFL	RANGE / CHARGE	TIME (SETTING)	ELEV	ROUNDS EXPENDED
		FFE			Sec	3 RDS PROX				0991	12 PROX
						EOM	EST	60%	CAS		
	NOTE: +48		x 3.0	= +144	-25	= +119	TRC				

DA FORM MAR 91 2399 REPLACES DA FORM 2399, 1 OCT 71 WHICH IS OBSOLETE.

Figure 14-6. Example of completed DA Form 2399 for firing a total range correction mission on the surveyed chart.

i. **Applying Firing Corrections**. Once the chart data have been determined, the computer applies the deflection correction by either adding or subtracting the deflection correction to the chart data determined. When working with deflection corrections, the computer uses the LARS rule. The deflection correction must be applied to each chart deflection throughout the mission.

EXAMPLE

2715 + L11 = 2726

(1) *Range correction*. Determine the initial chart range, then round to the nearest hundred and express it in thousandths; for example, 2975 = 3000 = 3.0. Multiply the range in thousandths times the RCF and use the sign of the RCF: 3.0 x +48 = +144. This gives the total range correction for this target.

(2) *Total range correction*. The total range correction (TRC) is the total correction that must be applied to get the command range to fire the target. TRC is the range correction (RCF x range in thousandths) plus or minus the altitude correction.

EXAMPLE

Range correction = +144 - 25 (altitude correction) = +119 TRC

The two factors (RCF and altitude correction) are compared. If one of these factors is a negative, subtract the smaller from the larger. The sign of the larger is used for the TRC. If both factors are negative or positive, then add the two factors to get the TRC. This must be applied to every chart range to obtain command range. To enter the firing tables, the command range is rounded to the nearest 25 meters.

j. **Firing Reregistration**. The FDC must consider weather changes to ensure the accuracy of the firing data (firing corrections) from the surveyed chart. Two methods can be used to do this: reregistration on the RP or MET message. Of those two methods, reregistration is the better because all the unknown (nonstandard) factors are fired out. However, due to countermortar-radar, determining and applying the MET messages may be safer. The choice is dictated by the tactical situation and the availability of MET messages.

(1) Fire the reregistration at the established RP using only the mortar that originally fired the registration (Figure 14-7). (The FDC assumes that the sheaf is still parallel; therefore, the sheaf should not need adjusting again.) The chart data are the same as with the initial registration. Apply the firing corrections to obtain the command data (Figure 14-8). (A blank reproducible copy of DA Form 2188-R, Data Sheet, is located at the back of this manual.)

COMPUTER'S RECORD

For use of this form, see FM 23-91. The proponent agency is TRADOC.

ORGANIZATION	DATE	TIME	OBSERVER ID	TARGET NUMBER
B Co 1/29 IN			P88	RP1

☑ ADJUST FIRE ☐ FIRE FOR EFFECT
☐ IMMEDIATE SUPPRESSION

GRID:
OT DIRECTION: 3800
ALTITUDE:

SHIFT FROM:
OT DIRECTION: ALTITUDE:
☐ LEFT / ☐ RIGHT
☐ ADD / ☐ DROP
☐ UP / ☐ DOWN

POLAR:
OT DIRECTION: ALTITUDE:
DISTANCE:
☐ UP / ☐ DOWN
VERTICAL ANGLE ☐ + / ☐ −

TARGET DESCRIPTION: RP1
METHOD OF CONTROL:
METHOD OF ENGAGEMENT:
MESSAGE TO OBSERVER: PREPARE TO RE REG RP1

FDC ORDER	INITIAL CHART DATA	INITIAL FIRE COMMAND	ROUNDS EXPENDED
MORTAR TO FFE: #2	DEFLECTION: 2790	MORTAR TO FOLLOW: #2	
MORTAR TO ADJ:	DEFLECTION CORRECTION: ☑ L ☐ R 11	SHELL AND FUZE: HE Q	
METHOD OF ADJ: 1 Rd	RANGE: 3050	MORTAR TO FIRE:	
BASIS FOR CORRECTION: RP1	VI/ALT CORRECTION: ☐ + ☑ − 50	METHOD OF FIRE: 1 Rd	1
SHEAF CORRECTION:	RANGE CORRECTION: ☐ + ☑ − 25	DEFLECTION: 2801	
SHELL AND FUZE: HE Q	CHARGE/RANGE: 6	CHARGE: 6	
METHOD OF FFE:	AZIMUTH: 3660	TIME SETTING:	
RANGE LATERAL SPREAD:	ANGLE T: 140	ELEVATION: 0958	
ZONE:			
TIME OF OPENING FIRE: W/R			

OBSERVER CORRECTION: DEV	RANGE	TIME (HEIGHT)	CHART DATA: DEFL L11	CHARGE (RANGE)	SUBSEQUENT COMMANDS: MORTAR FIRE	METHOD FIRE	DEFL	RANGE / CHARGE	TIME (SETTING)	ELEV	ROUNDS EXPENDED
R50	−100		2783	+125 2950			2794	3075		1001	2
	+25	EOM R/C	2777	2975			2788	3100		0991	3

NOTE: CHART DEF 2790
DEF 2788
R2 DEF CORR
CMD RNG W/O VI CORR = ADJ CMD RNG

ADV CMD RNG 3125
INT CHT RNG 3050
+75 RNG CORR
$3.1\overline{)75.00}$ = 24 RCF (+24.1)
3100 + 25 = 3125

DA FORM 2399, MAR 91 — REPLACES DA FORM 2399, 1 OCT 71 WHICH IS OBSOLETE.

Figure 14-7. Example of completed DA Form 2399 for a reregistration.

DATA SHEET

For use of this form, see FM 23-91; the proponent agency is TRADOC

SETUP		WEAPON DATA				FO DATA		
						FO	ALT	GRID
TIME OUT	60	UNIT	B 1/29	WPN 1	WPN	P88	620	010 622
TGT PRFX	AB		81 mm CAR	DIR 5250	DIR			
TGT NO	0100-0500			DIS 50	DIS			
ALARM	☐ ON ☑ OFF		☐ YES ☑ NO					
MIN E	096	BP	2	WPN 3	WPN			
MIN N	029			DIR 2050	DIR			
GD ☑ E ☐ W	10	E	0086	DIS 50	DIS			
LAT ☑ + ☐ -	34	N	6158					
LISTEN	☐ ON ☑ OFF	ALT	520	WPN 4	WPN			
BIT RATE	1200	AZ	3650	DIR 2050	DIR			
KEY TONE	1.4	DEF	2800	DIS 100	DIS			
BLK	☑ SNG ☐ DBL	ELE						
OWNER ID	A							

AMMUNITION DATA

TEMPERATURE 70° TYPE ☑ HE ☑ WP ☑ ILL ☐ CS ☐ TNG

LOT NUMBER	HE 6008	WP B008	ILL A06						
WEIGHT									
ON HAND	200	100	50						
RECEIVED	100	50	25						
TOTAL	300	150	75						
ROUNDS EXPENDED	24								
ROUNDS REMAINING	276								

TARGET DATA

TARGET ID			CHART DATA		FIRING CORRECTIONS				FIRING DATA				INTELLIGENCE				ROUNDS	
TGT NO.	GRID	ALT	DEFL	RG / CHG	DEFL CORR	RANGE CORR	ALT / VI	ALT CORR	DEFL	RG / CHG	FUZE TIME SETTING	ELEV	TIME FIRED	TGT DES	MET OF ENG	SUR	EXP	REM
RP1	9953 5884	470	2790	3050	L11	+150	470 / -50	-25	2801	3175		0958		RP #1		R/C S/A	7 HE	293
AB 0105		470	2715	2975	L11	+144	470 / -50	-25	2726	3100		0991		PIO	SEC 3 RD PROX	EST 60% CAS	14 HE	279
RP1		470			L11	-25	470 / -50	-25	2788	3100		0991		RP #1		RR/C	3 HE	276
					UP	DATING			AFTER	REREGISTRATION								
RP1			2790	3050	R2	+75	470 / -50	-25	2788	3100			0991					
AB 0105			2715	2975	R2	+72	470 / -50	-25	2713	3025			1019					

DA FORM 2188-R, DEC 91   REPLACES DA FORM 2188-R, MAR 77 WHICH IS OBSOLETE.

Figure 14-8. Example of completed DA Form 2188-R.

(2) The chart deflection plus or minus deflection correction equals command deflection. The chart range plus or minus the range correction plus or minus the altitude correction equals the command range.

(3) Carry out the mission the same as with the initial registration. Once the EOM, "Registration complete," has been given, determine firing corrections again.

(4) In the initial registration, the FDC compared the initial chart range and the final chart range difference. Determining the range difference after the reregistration is the same; however, now determine the final adjusted range. During the reregistration, firing corrections were applied for each round. Now apply those same corrections.

(5) Adjusted range is the final range with the correction for altitude correction deleted.

EXAMPLE

Final command range: 3,100 meters; altitude correction: -25.
Final adjusted range: 3,100 + 25 = 3,125.

The altitude correction is added since it was initially subtracted. If the altitude correction had been a plus (+), then it would have been subtracted to obtain the final adjusted range.

(6) Once the final adjusted range has been determined, compare the initial chart and the final adjusted range. Subtract the smaller from the larger to determine the RCF. The sign (+/-) would be determined as with the initial registration. Again, divide the range (initial chart range rounded to the nearest 100 expressed in thousandths) into the new range correction to determine the new RCF.

(7) To determine the deflection correction, compare the initial chart deflection and the final command deflection. Subtract the smaller from the larger and determine the sign (L or R) to apply.

(8) Apply the new firing corrections to all targets that have been and are fired within the transfer limits. For those targets that are already plotted on the board, apply the new firing corrections and update the target data. (The chart data do not change. The target has not moved; only the weather has changed.)

14-2. MEAN POINT OF IMPACT REGISTRATION

The FDC uses MPI registration during darkness and on featureless terrain to determine firing corrections. Two M2 aiming circles or radar must be used to conduct an MPI registration. (MPI registration can also be used for reregistration.)

a. **Conduct of an MPI Registration**. To fire the MPI registration, the FDC must proceed as follows:

(1) Set up the M16/M19 plotting board as a surveyed firing chart (eight-digit grids to the mortar position and RP).

(2) Plot the location and altitudes of the two FO points to be used.

Because the FOs will be sending azimuth readings for the impact points of the rounds, they must see the area of the RP using the M2 aiming circle.

(3) Record all data on DA Form 2188-R. To determine each FO's direction to the RP, rotate the azimuth disk until the FO's position is aligned with the RP. Read the azimuth scale to the nearest mil. To determine each FO's vertical angle, compare the altitudes of each FO's location and the RP, and subtract the smaller from the larger. This remainder is the VI, which is used to determine the vertical angle and carries the sign of the larger. Determine the range from each FO's location. Round the range to the nearest 100 and express it in thousandths. Divide the range expressed in thousandths into the VI and determine the product to the nearest whole mil. The sign (+/-) of the vertical angle (VA) is the same as the VI sign (+/-).

EXAMPLE

Assume that the VI is -80 for FO 1 and +50 for FO 2. The range for FO 1 is 2,525 meters; for FO 2 is 3,000 meters.

- 32
FO 1: 2525 = 2500 = 25/-800 VA: -32 mils

+ 16.6
FO 2: 3000 = 3000 = 30/+500.0 VA: +17 mils

Send the direction and vertical angle to the FOs so they can set up their M2 aiming circles.

(4) To determine the firing data, align the mortar position with the RP. Determine the chart data and apply the range correction for altitude between the mortar and target. During the registration, only the range correction for altitude is used. Give the firing command to the base mortar. Three to six rounds will be fired at 10-second to 20-second intervals. The FO uses this interval to give himself time to determine the azimuth readings to each round. If the azimuth for one or more rounds is determined to be 50 or more mils different, then another round may be fired for each erratic round. Six rounds are needed for the most accurate MPI registration, but as few as three rounds give correction data.

(5) As the rounds are fired, the FO reads the azimuth to each round and records it. When the last round has been fired, he sends the data recorded to the FDC. Once the rounds have been fired and the readings recorded in the FDC, plot the MPI as follows:

(a) Determine the total by adding all the readings from each FO.

(b) Divide the total by the number of readings to determine the average of the readings to the nearest mil.

EXAMPLE

	FO 1	**FO 2**
1	6104	0400
2	6110	0402
3	6105	0404
4	6106	0405
5	6107	0401
6	6109	0400
TOTAL	36,641 mils	2412 mils

$$\frac{6106.8}{6/36641} = 6107 \text{ mils (average azimuth)}$$

$$\frac{402}{6/2412} = 402 \text{ mils (average azimuth)}$$

NOTE: FO may send the average azimuth.

(c) Once the average azimuth for each FO has been determined, index the average azimuth and draw a line from each FO position toward the top of the board; where the lines intersect is the MPI. Determine and record the eight-digit grid coordinates and altitude of the MPI.

b. **Determination of Range Correction Factors**. With the MPI and RP on the board and the altitude determined, correction factors to be applied to other targets within the transfer limits of the RP must be determined. Again, because of the effects of interior and exterior ballistics on the round, the MPI may not be plotted in the same location on the plotting board as the surveyed point. Therefore, the corrections to hit that surveyed point must be determined. These corrections are noted on DA Form 5472-R, Computer's Record (MPI) (Figure 14-9). (A blank reproducible copy of DA Form 5472-R is located at the back of this manual.)

(1) **Range difference**. Compare the command range to the MPI point (minus the altitude correction) and the initial chart range to the RP.

EXAMPLE

Command range MPI = M Alt 500 mils, MPI Alt 450 mils, VI = -50, Alt Corr -25. Adjusted chart range to the MPI = command range 2,650 M + 25 (to delete altitude correction, reverse the sign) = 2,675 adjusted chart range to the MPI.

The sign of the range difference is determined by how the move from the MPI to the RP must be made. If the RP range is larger, the difference is a plus (+); if smaller, it is a minus (-).

EXAMPLE

Initial chart range to the RP is 2,600 meters; adjusted chart range to the MPI is 2,675 meters.

2,675 - 2,600 = -75 range difference

COMPUTER'S RECORD (MPI)

For use of this form, see FM 23-91; the proponent agency is TRADOC.

UNIT	DATE	TIME

MESSAGE TO OBSERVERS

PREPARE TO OBSERVE MPI REGISTRATION

OP# 1 DIR 6105 VA − 32

OP# 2 DIR 0400 VA + 17

REPORT WHEN READY TO OBSERVE

OBSERVER'S READINGS

ROUND NO	OP # 1	OP # 2
1.	6104	0400
2.	6110	0402
3.	6105	0407
4.	6106	0405
5.	6107	0401
6.	0109	0400
7.		
8.		
9.		
10.		
(MUST BE SIX USABLE AZIMUTHS)		
TOTAL OF AZIMUTHS (ADD EACH COLUMN)	36641	2412
AVG OF AZIMUTHS (TOTAL ÷ 6)	6107	0402
DIR TO MPI	6107	0402

VERTICAL ANGLE COMPUTATIONS

RP ALTITUDE 450

OP #	1	OP #	2
RP ALT	450	RP ALT	450
OP ALT	370	OP ALT	400
VI −	80	VI +	50
OP RANGE	2525	OP RANGE	3000
W / RXM		W / RXM	

(VI ÷ RN IN THOUSANDS = VA)

100/R		100/R	
VI × 100/R (NEAREST .1)		VI × 100/R (NEAREST .1)	
VA − (NEAREST MIL)	32	VA + (NEAREST MIL)	17

DATA SECTION

81-MM/60-MM

RP GRID ______ CHA ______ ELE ______

RP ALT	450	MPI ALT	450
MORT ALT	500	MORT ALT	500
VI −	50	VI −	50
ALT CORR −	25	ALT CORR −	25
RP CHART DATA		**MPI DATA**	
DEF	2790	DEF	2810
RN (MINUS ALT CORR)	2600	RN (MINUS ALT CORR)	2675
DEF CORR		**RANGE CORR**	
RP DEF	2790	RP RN	2600
MPI DEF	2810	MPI RN	2675
DIFF L/R	20	DIFF +	75
DEF CORR L	20	RCF +	27
(TO APPLY, REVERSE SIGN)		(TO APPLY, REVERSE SIGN)	

4.2-INCH

MPI ALT ______ CHA FIRED ______

MORT ALT ______ CHA CORR ± ______

VI ______

(USE THIS VI TO COMP CHA CORR)
(SUBSTRACT IF +, ADD IF -)

CHART CHARGE TO MPI ______

CHART DEFL TO MPI ______

(DRAW THE ADJ CHC GAGE LINE FROM THE MPI POINT TO THE CHART CHG OF THE MPI POINT)

CHART RANGE TO MPI ______

DEFL FIRED ______

DEFL CORR R/L ______

(DETERMINE THE LARS CORR TO GET FROM MPI TO RP DEFL)

GRID OF MPI ______

DA FORM 5472-R, OCT 85

Figure 14-9. Example of completed DA Form 5472-R, Computer's Record (MPI).

(2) *Range correction factor*. Once the range difference has been determined, divide it by the chart range to the MPI rounded to the nearest 100 expressed in thousandths and round it to the nearest whole meter. The sign is the same as the range difference.

EXAMPLE

Range difference - 75; chart range to MPI 2,675 meters.	-27.8 =	-28 meters = RCF
Rounded to the nearest 100 = 2,700 meters	2.7/-75.00	
Expressed in thousandths = 2.7	54	
	210	
	189	
	210	

(3) *Deflection correction.* Compare the chart deflection of the MPI and the chart deflection of the RP (Figure 14-9) to determine the deflection correction. The sign of the deflection correction will be determined by how the move from the MPI to the RP must be made.

RULE: RP deflection is greater than the MPI deflection = LEFT deflection correction.
RP deflection is less than MPI deflection = RIGHT deflection correction.

EXAMPLE

MPI chart deflection = 2810;
RP chart deflection = 2790.
2810 - 2790 = L20 (correction to apply R20)

The application of the correction factors to other targets, within the transfer limit of the RP, is the same as with the other registration corrections except that the sign of the corrections must be reversed.

NOTE: The only time the corrections will be applied with the signs as determined is when the corrections are being applied to move the strike of the round from the MPI to the RP.

14-3. VERTICAL INTERVAL CORRECTION FACTORS

When the mortar position is known to surveyed accuracy and a map is being used, the computer can work with altitude differences and the correction factor for those altitude differences. As noted earlier, the term used for altitude difference is vertical interval (VI).

a. **Determination of Vertical Interval**. The computer compares the altitude of the mortar position and the altitude of the target being engaged. If the altitude of the target is higher than that of the mortar position, then the VI will be a plus (+); if lower, it will be a minus (-) (Figure 14-10).

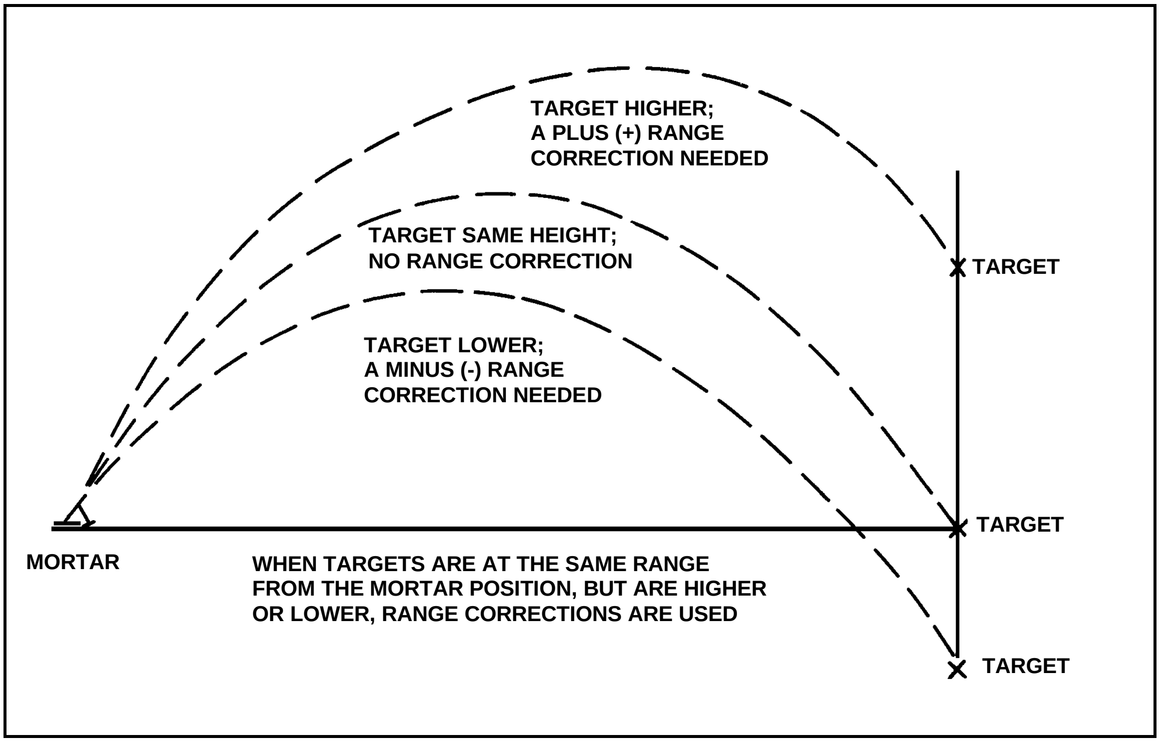

Figure 14-10. Altitude correction.

b. **Correction for Vertical Interval**. Because of the VI, a range correction must be applied to the chart range to obtain the range to be fired (command). The range correction to apply is half of the VI; it is determined to the nearest whole meter.

EXAMPLE

VI = 75 meters
1/2 = 38 meters (altitude [range] correction)

The altitude (range) correction must be 25 meters or more to be applied. The range correction is then added to or subtracted from the chart range. If the target is higher than the mortar, the computer adds the range correction; if lower, the computer subtracts to get the altitude to be fired (command). The altitude correction is applied to every chart range throughout the mission.

NOTE: A VI of less than 50 meters is not used when working with the modified-observed chart.

c. **Determination of Vertical Interval for Different Missions**. When there is a difference in altitude between the mortar position and the target, a range correction is made. Since the mortar round has a steep angle of fall, corrections are made only when differences of 50 meters or more in altitude exist. The chart range is corrected by one-half the difference in altitude expressed in meters. The correction is added when the target is above the mortar, and subtracted when the target is below the mortar. Difference in altitude can be determined from contour maps, by estimating, or by measuring the angle of sight, and by using the mil-relation formula.

(1) *Grid missions*. The target is plotted on the map and the altitude determined. If the altitude of the target cannot be determined, then the computer assumes that it is the same as that of the mortars.

(2) *Shift missions*. The target is assumed to be the same altitude as the point being shifted from unless, in the call for fire, the FO sends a vertical shift (up or down). Therefore, that shift is applied to the point being shifted from, and that is the altitude of the new target.

(3) *Polar missions*. The altitude of the target is assumed to be the same as that of the FO's position if no vertical shift is given. If one is given, then the computer applies the shift to the FO's altitude, and that is the altitude of the new target. Once the computer has determined the altitude of the target, then it is possible to determine the VI for the mission and, finally, the altitude correction to apply. Remember, VI is the difference in altitude between the mortars and the target.

14-4. RADAR REGISTRATION

Radar registration is another method used by the FDC to obtain firing corrections to apply to the firing data to obtain better accuracy.

a. Two types of radar units can be used: AN/PPS-5, which gives direction and distance to impact; and AN/PPS-4, which gives grid of impact. The one used will determine which method the FDC will use during the registration. At the unit level, the AN/PPS-5 will probably be used for the 60-mm and 81-mm mortars; the AN/PPS-4 for the 4.2-inch and 120-mm mortars.

NOTE: Registration of the AN/PPS-5 is explained here for the 60-mm and 81-mm mortars.

b. The M16/M19 plotting board must be set up as a surveyed firing chart. That is, the mortar position, RP, and radar site must be plotted to surveyed accuracy. The procedure for obtaining firing data is the same as with a regular registration mission. The altitude correction is the only firing correction used. Because this is a polar-type mission, the VI is now obtained as with a polar mission. The firing corrections are obtained in the same manner as with the regular registration mission.

c. After the board is set up and the direction and distance from the radar to the target have been determined, the FDC informs the radar operator of this information. The radar operator then orients the radar set using the information and calls the FDC when the set is ready. Once the radar is ready, the FDC then gives the initial data to the mortar section. The base mortar will adjust and then the sheaf will be established.

(1) When the first round impacts, the radar operator sends the FDC the direction and distance to that round.

(2) The FDC then indexes that direction and plots the round at the distance sent (the plot is made from the radar position plot, using the distance sent).

(3) The FDC indexes the mortar RP azimuth and determines the spotting by comparing the round's impact plot with the RP plot. The FDC, acting as the FO, determines all spottings (Figure 14-11).

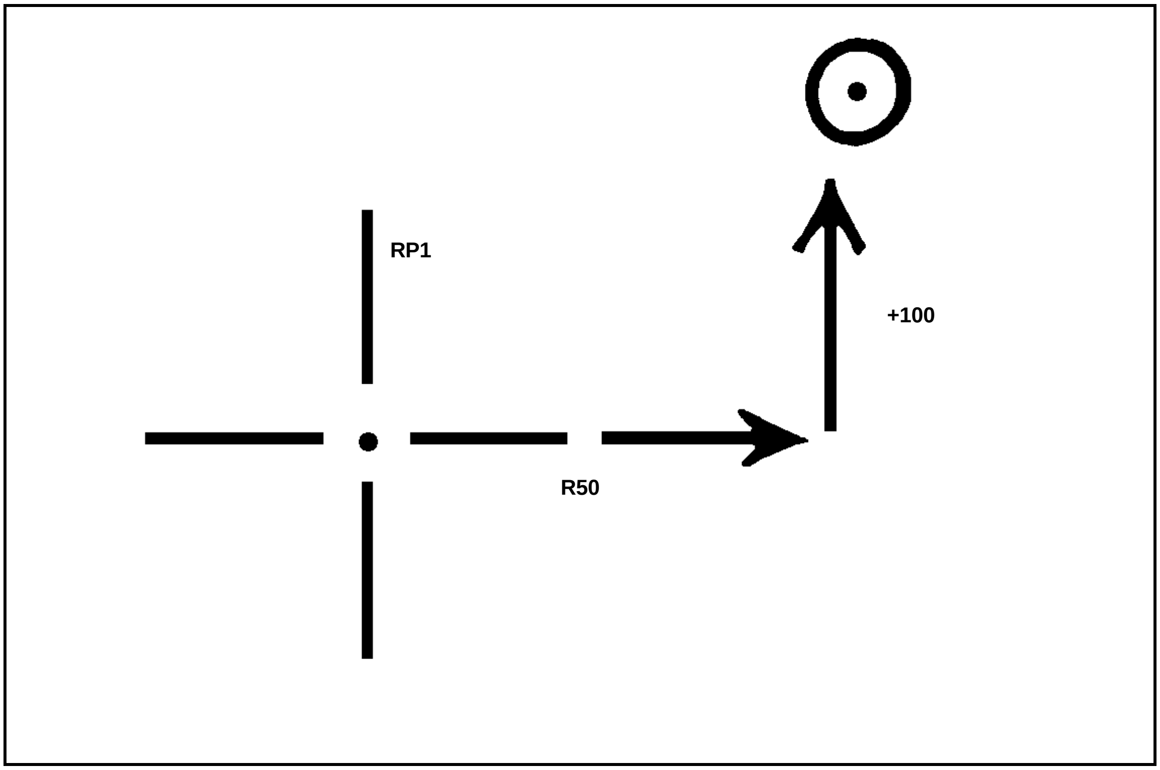

Figure 14-11. Determination of a spotting.

(4) Once the spotting has been determined, the FDC converts the spotting into a correction to fire the second round. He does this by reversing the signs of the spotting. He then applies that to the registration point on the azimuth of the radar position (Figure 14-12).

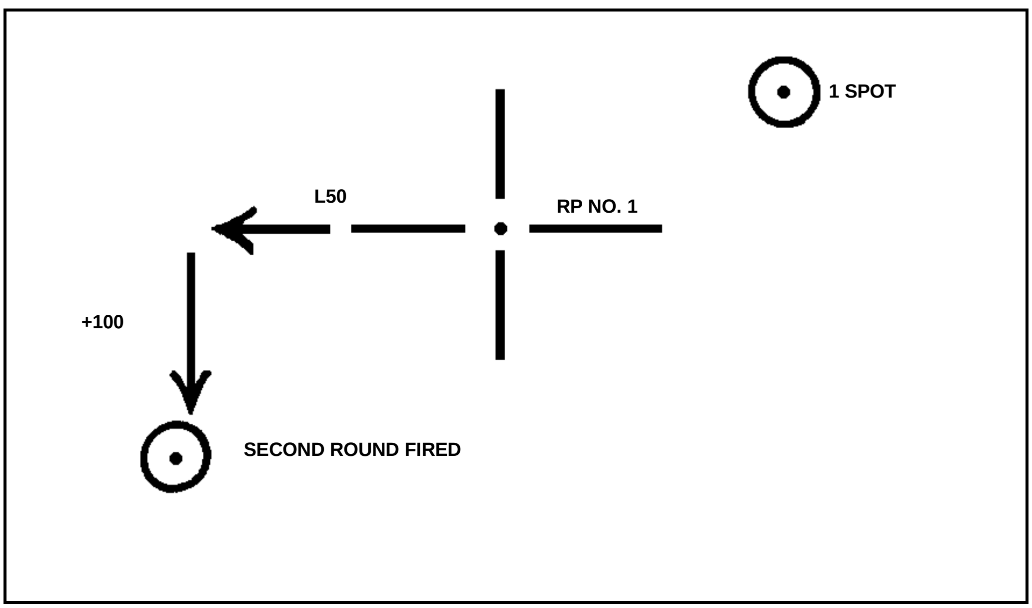

Figure 14-12. Application of correction to fire the second round.

(5) The firing data are then obtained by aligning the new plot with the mortar position.

(6) The spottings for additional rounds are spotted from the initial RP, but the corrections (spotting reversed) are applied to the last fired plot. This procedure is repeated for all adjustment rounds until a range correction of 50 meters is split.

14-5. FINAL PROTECTIVE FIRES

The highest priority mission for the mortar section is FPF. The FPF is a barrier of steel designed to stop the enemy. It is integrated with the other weapons of the unit being supported to cover dead space or likely avenues of approach. The FPF is a last-ditch effort to stop the enemy force from overrunning the unit. Normally, it is placed not more than 200 meters in front of friendly forces; however, the exact position of the FPF is based on the tactical situation.

a. The M16/M19 plotting board can be set up as any one of the three firing charts for FPF. With regard to the area of an FPF, the 60-mm and 81-mm mortar platoons can fire up to three FPF (one for each mortar).

b. The target location given in the call for fire is not the location of the FPF. A 200-to-400-meter safety factor is added to the location of the FPF by the FO. This is the location given in the call for fire.

NOTE: The computer *never* adds a safety factor.

c. An FPF adjustment can be fired in three ways:

(1) Adjust each mortar onto the FPF (most desirable method).

(2) Adjust only the danger-close mortar, using the attitude of the target and mortar position to compute data for the other mortars.

(3) Using the attitude of both the mortar section and the FPF, compute only the data for the FPF, with no rounds being fired (least desirable method).

d. Obtaining the firing data is still performed by aligning the mortar location with the plot being engaged and using the azimuth disk and vernier scale.

NOTE: If the FPF is within 200 meters of friendly troops, the FO should call for HE delay in adjustment (preferred method) and use the creeping method of adjustment.

e. When adjusting each mortar, the FO may (in the call for fire) give a section left (SL) or section right (SR) to determine the danger-close mortar. The danger-close mortar is the one impacting closest to friendly troops.

(1) Once the danger mortar is known (Figure 14-13), it is adjusted onto the FPF line.

(2) Once the danger mortar has been adjusted, the next mortar (No. 2) is given the danger mortar data and fired. The firing of the same data should put the impact of the next mortar 40 meters left or right of the adjusted mortar.

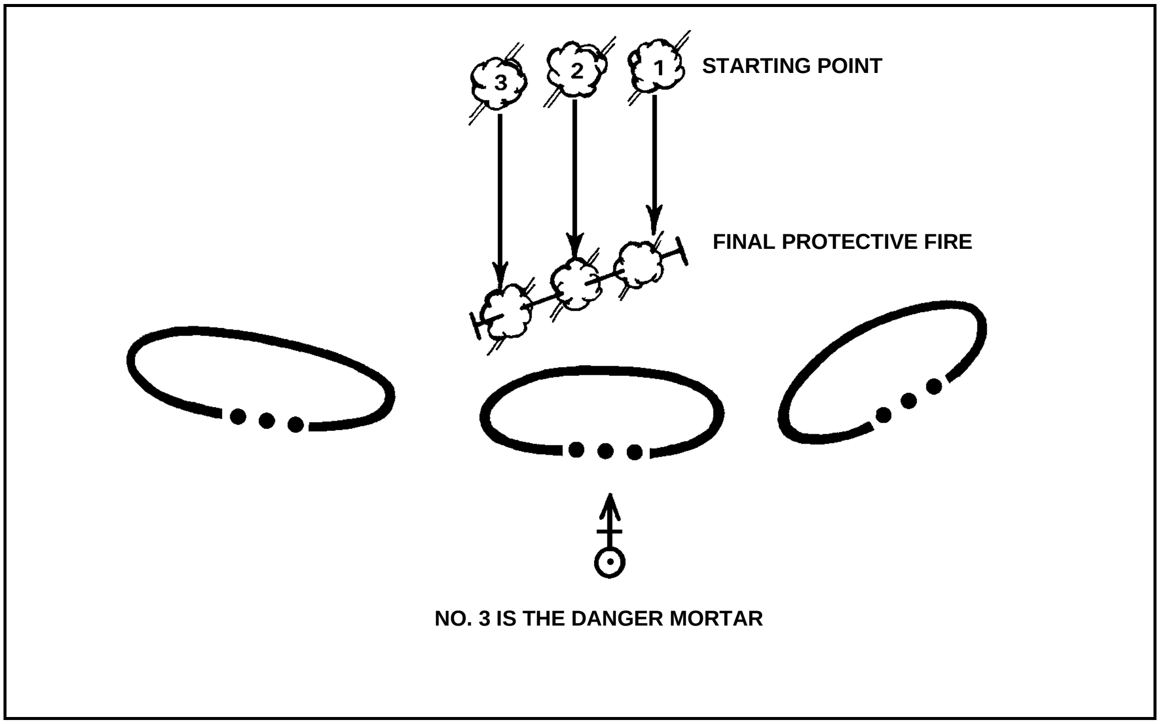

Figure 14-13. Determination of danger mortar.

(3) This procedure is used for the remaining mortars until each is on the FPF line. As each mortar is adjusted to the FPF line, the data are then given to each mortar and placed on the mortar after each mission. Also, the predetermined number (unit SOP) of rounds are set aside ready to fire (Figure 14-14).

COMPUTER'S RECORD

For use of this form, see FM 23-91. The proponent agency is TRADOC.

ORGANIZATION	DATE	TIME	OBSERVER ID	TARGET NUMBER
B Co 1/29 IN			P88	FPF

☑ ADJUST FIRE ☐ FIRE FOR EFFECT

☐ IMMEDIATE SUPPRESSION

(ENCODED)

GRID: 009 644

OT DIRECTION: 3020

ALTITUDE:

SHIFT FROM:

OT DIRECTION: ALTITUDE:

☐ LEFT / ☐ RIGHT

☐ ADD / ☐ DROP

☐ UP / ☐ DOWN

POLAR:

OT DIRECTION: ALTITUDE:

DISTANCE:

☐ UP / ☐ DOWN

VERTICAL ANGLE ☐ + / ☐ –

TARGET DESCRIPTION: FPF ATT 3740

METHOD OF CONTROL: SECTION LEFT

METHOD OF ENGAGEMENT: DANGER CLOSE

MESSAGE TO OBSERVER:

FDC ORDER	INITIAL CHART DATA	INITIAL FIRE COMMAND	ROUNDS EXPENDED
MORTAR TO FFE Sec	DEFLECTION 2800	MORTAR TO FOLLOW Sec	
MORTAR TO ADJ	DEFLECTION CORRECTION: ☐ L ☐ R	SHELL AND FUZE HED	
METHOD OF ADJ 1 Rd S/L			
BASIS FOR CORRECTION	RANGE 2775	MORTAR TO FIRE 1 Rd S/L	
SHEAF CORRECTION	VI/ALT CORRECTION: ☑ + ☐ – 70	METHOD OF FIRE	
SHELL AND FUZE HEQ IN ADJ HEQ IN FFE			4
	RANGE CORRECTION: ☑ + ☐ – 35	DEFLECTION 2800	
METHOD OF FFE 20 RDS		CHARGE 5	
RANGE LATERAL SPREAD	CHARGE/RANGE 5	TIME SETTING	
ZONE	AZIMUTH 2630	ELEVATION 0984	
TIME OF OPENING FIRE AMC	ANGLE T 390		

OBSERVER CORRECTION			CHART DATA		SUBSEQUENT COMMANDS						
DEV	RANGE	TIME (HEIGHT)	DEFL	CHARGE (RANGE)	MORTAR FIRE	METHOD FIRE	DEFL	RANGE / CHARGE	TIME (SETTING)	ELEV	
#1 L100	-100		2820	2825	#1		2820	2850/5		0899	5
	-50		2814	2800	#1		2814	2825/5		0918	6
#1 ADJ	REPEAT	#2			#2		2814	2825/5		0918	7
R50	-50		2825	2750	#2		2825	2775/5		0949	8
#2 ADJ	REPEAT	#3			#3		2825	2775/5		0949	9
L20	-25	EOM FDF ADJ	2830		#3	DNF	2830	2750/5		0963	

DA FORM MAR 91 2399 REPLACES DA FORM 2399, 1 OCT 71 WHICH IS OBSOLETE.

Figure 14-14. Example of completed DA Form 2399 for computing FPF missions.

f. When adjusting only the danger-close mortar, the computer is given the attitude of the target in the call for fire.

(1) The FDC can determine the danger-close mortar by indexing the target attitude and drawing a line from the initial FPF plot (given in the call for fire) 50 meters above and below (Figure 14-15).

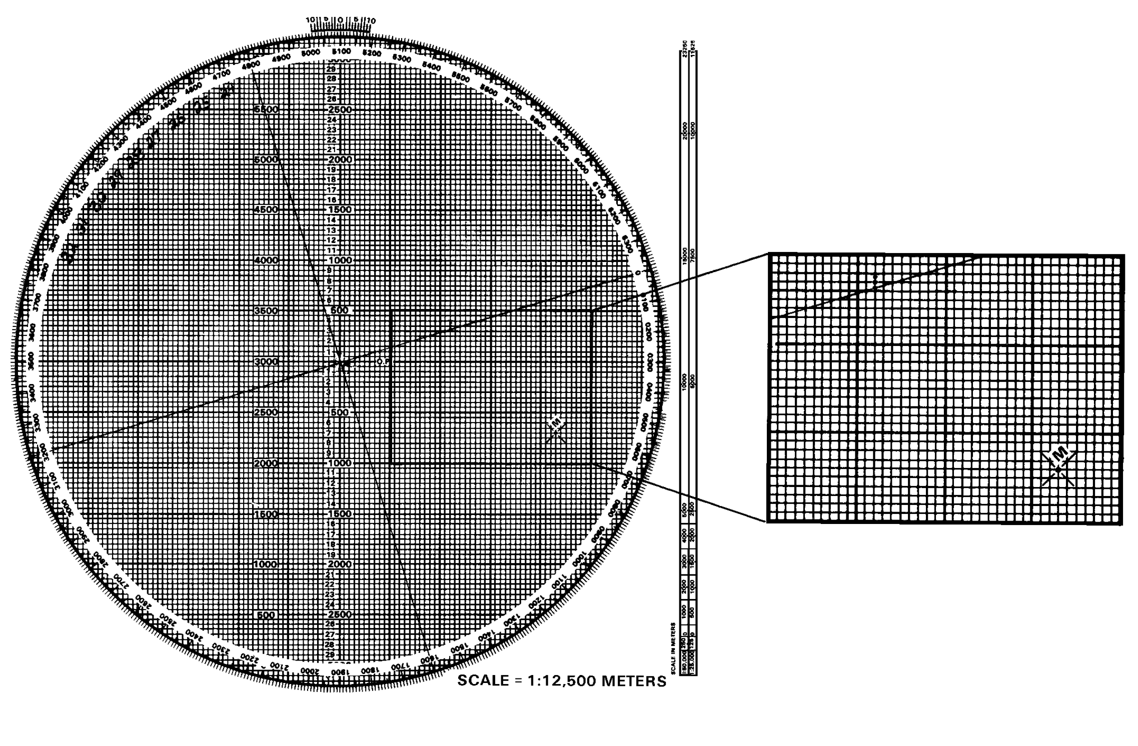

Figure 14-15. Drawing FPF symbol with attitude indexed.

(2) After drawing the FPF line, the computer rotates the azimuth disk and aligns the mortar plot with the FPF plot to see which side of the line is closest to the friendly troops (Figure 14-16).

(a) To use this method, the frontline trace of the supported unit must be plotted on the board.

(b) Once the danger mortar has been determined, that danger mortar is fired and adjusted to the FPF line.

(3) After the danger mortar is adjusted to the FPF line, the computer then indexes the FPF attitude and erases all but the last plot.

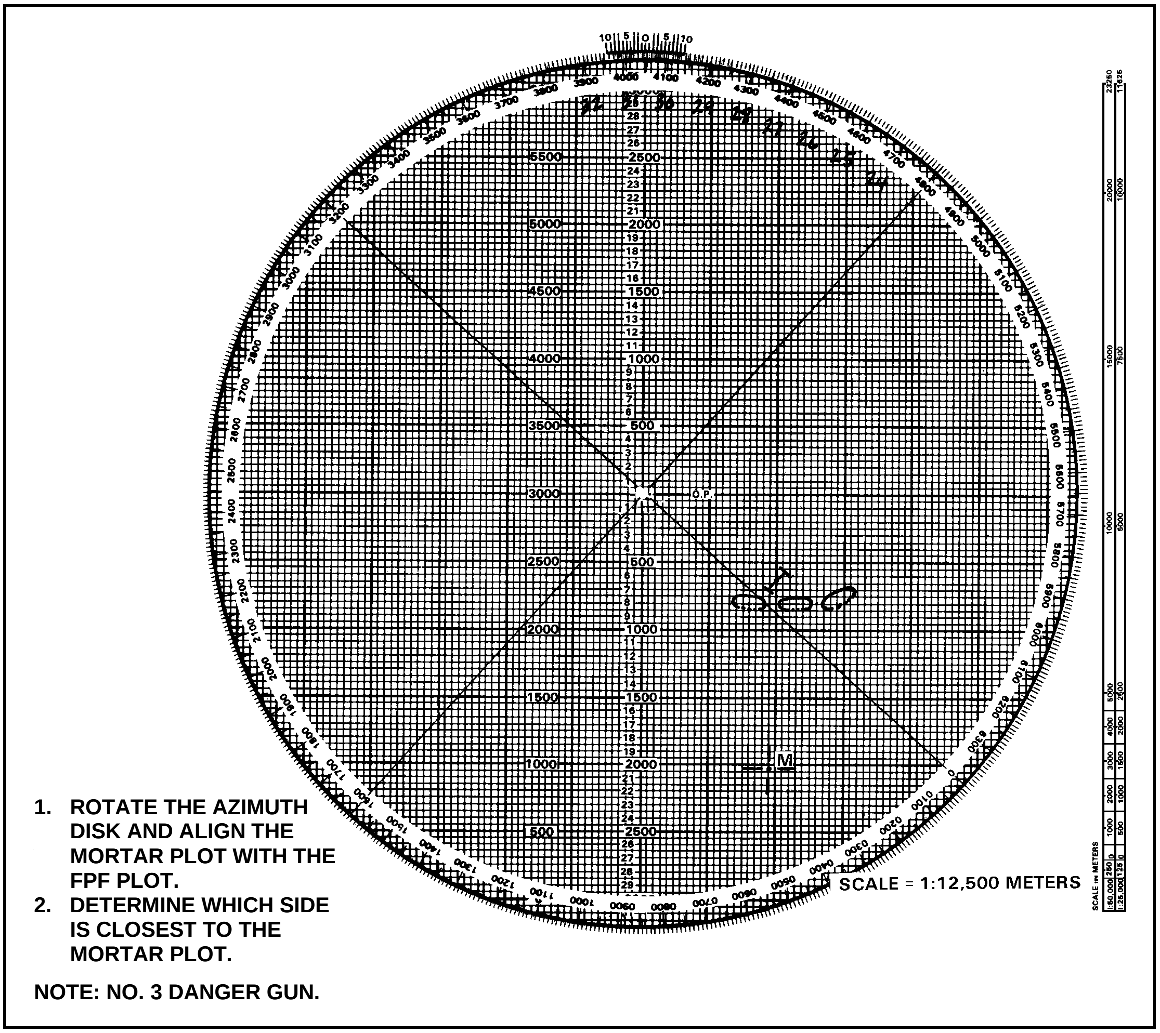

Figure 14-16. Determination of danger mortar.

(4) Using the last plot, the computer draws the FPF symbol by extending a line 90 meters long toward the top of the board and 10 meters long from the plot towards the bottom of the board. This shows the full 100-meter width of the FPF.

(5) The remaining plots for the No. 1, No. 2, and No. 3 mortars are then plotted 40 meters apart (Figure 14-17).

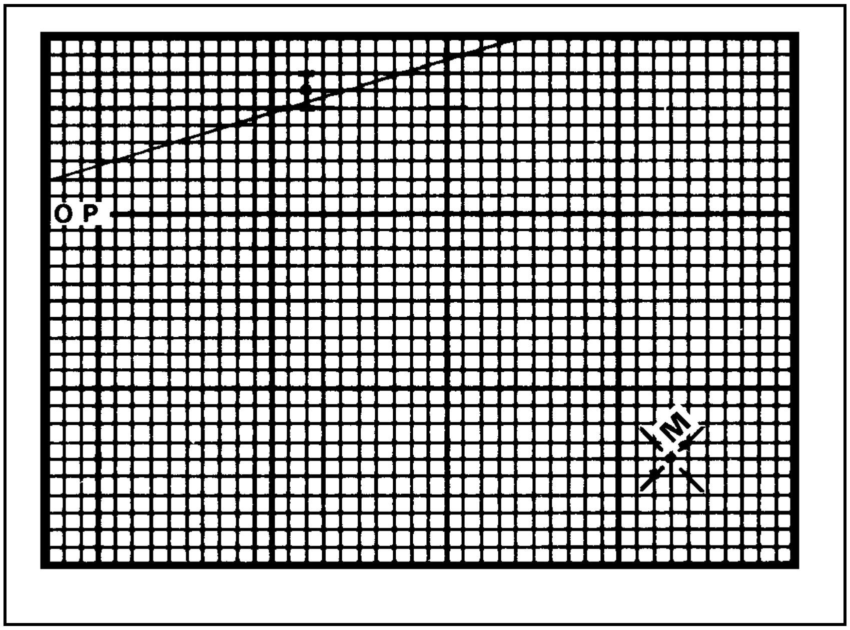

Figure 14-17. Plotting of No. 1, No. 2, and No. 3 mortars.

(6) Once the plots are on the plotting board, the computer determines the firing data for each mortar by aligning each mortar plot with its intended impact plot (Figure 14-18).

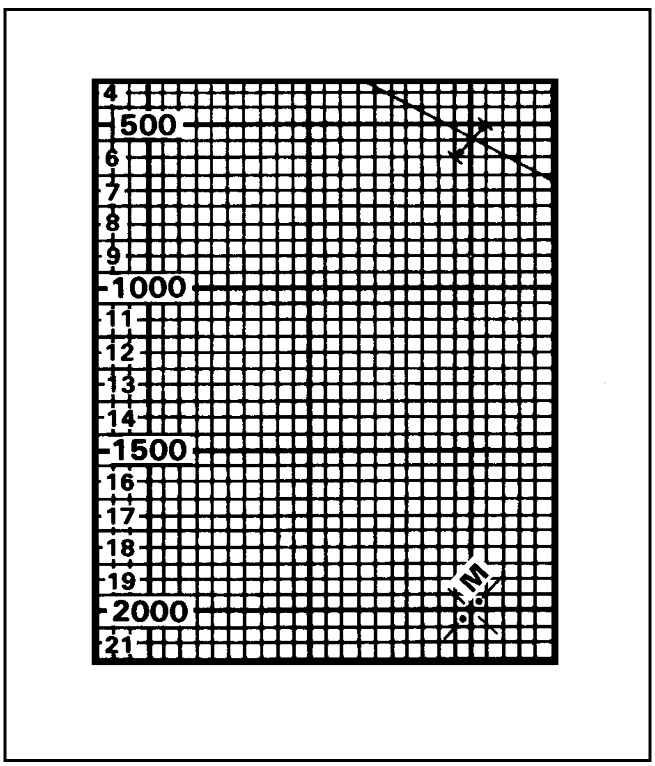

Figure 14-18. Alignment of each mortar with its impact point.

(7) Again, these data are placed on the mortar after each mission, and the rounds are readied to fire.

g. To compute data for FPF without adjustment, the computer indexes the attitude of the FPF line and makes a plot 40 meters above and below the FPF starting plot.

(1) The computer then indexes the attitude of the mortar section and plots the No. 1, No. 3, and No. 4 mortars 40 meters above and below the No. 2 mortar plot.

(2) Once the FPF and mortars have been plotted, each mortar is aligned with its impact plot, and the data determined.

(3) These data are given to the mortars and, again, are set on the mortars between missions.

(4) This method is used when ammunition is low and time or the tactical situation does not permit the adjustment of the FPF.